

The author presents an overview of the uses of diagnostic radiology and the influences that lead physicians to employ it.

THE JUDICIOUS USE OF DIAGNOSTIC RADIATION IN THE HEALING ARTS

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RADIATION has unfortunately become a fearful word to the uninitiated. This is partly due to the lack of understanding of its meaning, and partly to misinformation that has appeared in household magazines and in the lay press. Consequently, it is not unexpected that many persons express anxiety at the prospect of being x-rayed, even for a justifiable medical reason.

We all live in an environment of natural background radiation, and there is very little that can be done to change this situation. Our present concern is the additional radiation generated by man, and our efforts should be directed to a reduction of this exposure. However, it is equally important that misconceptions of the risks involved do not discourage an individual from receiving the benefits available from the correct use of a diagnostic x-ray procedure.

Diagnostic radiology has had a far-reaching influence on the practice of medicine. At the present time, approximately 50 per cent of the diagnoses in clinical medicine are either made or confirmed by radiological procedures.¹ The magnitude of usage of this modality in clinical medicine is best illustrated by the 1964 report on the Public Health Service Population Exposure to X-rays.² It was estimated that 108 million persons, or 58 per cent of the population of the United States, had one or more x-ray examinations in 1964. Of this number,

66 million had radiographic examinations; 46 million had dental x-ray examinations; 8 million had fluoroscopic studies, and approximately 600,000 received x-ray therapy. Approximately 60 per cent of all examinations, excluding dental, were to some degree under the supervision of a radiologist.

The volume of diagnostic radiological procedures, indicated by these figures, is large and is increasing at a rate in excess of 7 per cent each year.³ This demand has created a serious manpower shortage within the specialty of radiology, and there is no easy solution to this problem. It has been estimated that 25 per cent of a radiologist's time is required for the sophisticated special procedures, yet these examinations account for only 3 per cent of all services rendered.³ Although approximately 6 per cent of medical graduates choose radiology as a specialty, this number is inadequate to meet the needs.

The Hill-Burton Act, for example, requires the installation of diagnostic x-ray facilities in the new, small, rural and suburban hospitals to qualify for funds. This has had the effect of rather evenly distributing diagnostic x-ray equipment between the rural and metropolitan areas. However, specialized radiological services are still largely unavailable in rural areas because radiologists tend to concentrate in the larger metropolitan areas. As a result, a nonradiologist phy-

sician, because of the availability of x-ray equipment, may tend to go beyond his area of competence.

Ideally, radiology should be a consultative procedure in which the referring practitioner discusses with the radiologist the indications for an examination of his patient. However, the scarcity of radiologists by number and location prevents this highly desirable procedure from being a fact in many medical communities. As a result, the indications for a given radiologic examination and the frequency of reexamination may be the responsibility of the referring physician. Therefore, this physician should have knowledge of the radiation involved in the requested examination, and be able to balance beneficial yield against the potential risk to his patient. He must evaluate the medical problem presented by the patient in relation to the confirmatory information obtained from the procedure. A radiological examination must not be used as a substitute for a proper history and physical examination. It should be considered as a means of substantiating a diagnosis and not a means of determining a diagnosis by exclusion. A physician must not deny examination of a patient if it is indicated, but he should discourage the occasional patient who demands an x-ray examination without some relation to possible pathology.

The radiologist who actually performs a radiological examination should know and understand the medical problem involved. This is necessary, so that he may select suitable and adequate procedures. It will allow him to control the exposure and to evaluate the necessity for reexamination. If the need for radiological examination is not clearly indicated by the medical problem, such examination would result in unnecessary exposure to the patient and should be avoided. Also implied here is the fact that radiation that does not contribute

to the production of the image is unnecessary and unproductive radiation. It is logical that the physician who requests or actually performs a radiologic procedure must first assure himself that the examination is necessary for the welfare of his patient.

The physician without specialized training in radiology must assume the responsibility for the use and safety of his equipment, and he must provide protection for the patient, himself, and his office personnel in the same fashion as the radiologist. This point is emphasized by a study of Seltser and Sartwell which supports the hypothesis that exposure to ionizing radiation had a life-shortening effect on radiologists and other physicians who used x-rays in their practice.⁴ This was probably true among the pioneers in radiology, but should not be true with the equipment and protective measures available to physicians properly trained in their use.

Several procedures utilizing radiation in the healing arts deserve special consideration.

Fluoroscopy

Fluoroscopy is one of the most widespread diagnostic procedures used by physicians. A major reason for this is the simplicity of the fluoroscopic examination when compared to radiographic procedures. For example, the unit is small and does not require expensive film or processing tanks. However, without image intensification, the exposure of the patient may be a hundred times that required for a more informative radiograph. The length of exposure is dependent upon the skill, experience, and technique of the operator, assuming that the equipment is in good condition.

Fluoroscopic equipment with image intensification should replace the older screen system as rapidly as possible. A survey of medical x-ray equipment in 25 states and 2 territories listed only

178 image intensifier systems out of a total of 2,266 fluoroscopic installations. More than half of the image intensifier systems were located in hospitals and radiologists' offices.⁵

Fluoroscopy should be used as a supplement to a radiograph and should be limited to the study of the dynamic phenomena of an organ system. It should never be used as a substitute for a diagnostic radiograph if this is available. Fluoroscopy alone cannot be relied upon in the detection of early inflammatory disease of the chest or a malignancy in its early stages. The American Academy of Pediatrics has advised pediatricians to discontinue the use of fluoroscopy, and to substitute radiographic procedures with the resultant decreased exposure to the infant or child.⁶

Diagnostic Procedures During Pregnancy

A recent national survey was conducted by the National Center for Radiological Health to determine the medical x-ray visits during pregnancy, and the trimester of the pregnancy in which the examination was made. During the first trimester, 21 per cent of the examinations occurred; during the second trimester, 25 per cent, and during the third trimester, 54 per cent.⁷ These figures indicate the prevalence of radiological procedures for the pregnant woman, and the necessity for careful evaluation of the possible benefit to be obtained. In 1962, the International Commission on Radiologic Protection recommended that the 10-day interval following the onset of menstruation should be the only time when a woman of reproductive age should have a radiographic examination of the pelvis and abdomen, unless it is of an emergency nature.⁸ MacMahon reported in 1963 that data from 12 studies provided an indication that mortality from leukemia

and other forms of childhood cancer may be higher among children exposed to radiation in utero than in children not exposed.⁹ This finding has been substantiated by the studies of Alice Stewart in the United Kingdom.¹⁰

Location of the placenta is occasionally necessary in the third trimester of pregnancy because of hemorrhage. This may be done with the patient in an outpatient status within a matter of minutes by the use of a scanning technique that uses radioactive technetium, resulting in a maternal total body dose of 5 mrad and a fetal blood dose of 14 mrad. In contrast, the fetal dose from a single A.P. radiograph of the pelvis has been estimated to be 200-300 mrad, and usually more than one film is required for placenta location.¹¹ Information of this kind should be known by all physicians, especially those responsible for the care of obstetrical cases.

Mass Surveys Using the Chest X-ray

Radiological examinations are used in mass surveys for the detection of tuberculosis, occupational pulmonary disease, malignancy of the lung, and other chronic pulmonary disease processes. The rationale is the discovery of active communicable disease that requires treatment and/or the early detection of malignant disease still in a curable state. Mass tuberculosis case-finding surveys were introduced on a wide scale shortly after World War II. These programs were of value in placing persons with active disease under treatment and thus preventing the spread of the disease. With improved control of tuberculosis, yields of community surveys have often become too low to warrant mass screening. However, there are certain geographical areas and population groups where tuberculosis is still a public health problem. It is only toward these segments of the population that mass survey efforts should continue to be di-

rected. Health authorities have recommended that two or three cases per 10,000 examinations would be a reasonable yield.¹²

Volunteer health agencies with mass x-ray survey programs should be aware of the radiation exposure involved in the photofluorographic chest examination and the limited information obtainable from this procedure. It has been estimated that this method may require up to 50 times more exposure to an individual than conventional radiographs taken under ideal circumstances.

Employment Surveys

Pre-employment physical examinations of healthy young men have occasionally included radiographs of the lumbar spine of those individuals expected to perform heavy manual labor. This procedure may be considered beneficial to the employee if spinal defects are found, prior to an assignment requiring heavy lifting. The employer may benefit by avoiding possible subsequent claims for occupational injury if spinal abnormalities are a part of the pre-employment health record. However, radiographic examination of the lumbar spine and the bony pelvis should not be a routine procedure. It should be limited to individuals with a definite history and physical findings of low-back instability. The radiographic examination, when indicated, should be performed with precise collimation, proper selection of film size, and careful gonadal shielding.

Periodic medical examination of executives of various companies is a valuable procedure in the detection of unknown disease. The benefit is obvious for the individual found to have a serious disease. The discovery of such a disease permits the employer to plan replacement or retirement of the executive without disruption of continuity. Some companies require that these periodic examinations include "routine"

radiological studies of the gastrointestinal tract and chest.¹³ This type of executive examination should be limited to individuals over the age of 45 or to those in whom there is a definite medical indication. The examining physician has the responsibility to determine the type and extent of any radiological procedures to be included in such executive examinations. The so-called "routine x-ray procedures" should be abandoned.

The Threat of Malpractice

Legal implications may influence the attending physician's decision to obtain an x-ray examination of his patient. The specter of a malpractice suit is ever present today in the practice of medicine, and more prevalent in some areas of the country than in others. We are all aware that one out of five physicians, at some time in his medical career, will have a malpractice suit filed against him.

As a result of this possibility, a physician may order x-ray examinations to protect himself, although there may be no real medical indication. He may suggest that follow-up films be taken at frequent intervals, rather than when medically indicated, to avoid possible later entanglement with the plaintiff's attorney in court on whether an adequate x-ray examination was made. Thus, the possibility of a malpractice suit may have a profound influence on the judgment used by physicians in the clinical use of radiation. This is particularly true in the accident cases.

Summary

Dr. Lauriston S. Taylor, President of the National Council on Radiation Protection and Measurements, recently stated that "the application of radiation to patients is a matter of medical judgment and is not appropriate for regu-

lation. Any attempt to regulate this would be retrograde in terms of the patient obtaining maximum benefit from a critically important diagnostic tool."

How, then, might we better acquaint the physician with the benefits available from radiological procedures, as well as the potential risks, in order to influence his judgment? It is obvious this should begin with the medical student's education in the correct use of ionizing radiation for such procedures. It is only through a continuing process of education that the physician in practice is able to appreciate and apply the information available from the sophisticated radiological procedures of today. Transfer of this type of knowledge from the academic institutions to the physician in practice is one of the most difficult problems in the continuing education field.

Research into the productivity of specific examinations is needed and necessary in order to determine which radiological procedures should be requested and which should not be requested in any given medical situation. For example, the productivity of pre-employment low-back x-ray examinations and the so-called "routine gastrointestinal series" should be determined.

A physician's reason for requesting an examination may appear intuitive, but it actually reflects a breadth of knowledge and experience in medicine. This process may well define clinical judgment.

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